

REMARKS

Examiner H. Lee is thanked for the thorough examination and search of the subject Patent Application. Claims 1, 8, and 15 been Amended. Claims 28-31, 34-35, and 37-40 have been or remain Canceled.

All Claims are believed to be in condition for Allowance, and that is so requested.

Reconsideration of Claims 15-19 and 22 rejected under 35 U.S.C. 102(e) as being unpatentable over Lin (U.S. 6,426,556) is requested based on Amended Claim 15 and on the following remarks.

Claim 15 has been amended to now read as follows:

15. (Currently Amended) A method for forming a metal bump on a semiconductor substrate, comprising the steps of:

providing a semiconductor substrate, said semiconductor substrate having been provided on the surface thereof with a contact pad, said contact pad overlying a layer of dielectric, said layer of dielectric having been deposited over said semiconductor substrate; and

partially removing said contact pad in accordance with  
a mask of passivation material, said removing having a  
10 removal thickness and removal surface area wherein said  
mask is not removed during further processing. ~~wherein said~~  
~~mask of passivation is not photoresist.~~

The phrase, "wherein said mask of passivation is not photoresist," was deemed by the Examiner as new matter. Therefore, this phrase has been deleted by amendment. However, to clearly distinguish Applicant's claimed invention from the teaching of the cited art of Lin, the phrase, "wherein said mask is not removed during further processing" is added. This phrase clearly does not represent new matter as seen by Figs. 2a through 20d. In all cases, the mask of passivation material 32 that is used for defining the removal region for the contact pad 24 remains in place during further processing and, in fact, is sealed into the integrated circuit by subsequent deposition of overlying layers such as UBM 33.

The cited art of Lin, by comparison, teaches the use of a patterned photoresist layer 37 to define the region of the contact pad 24 that is etched down (Fig. 10). **Most importantly,** this patterned photoresist layer 37 is then removed (Fig. 11) prior to the deposition of subsequent layers such as UBM layer

**33 (Fig. 12).** A clear and distinct difference is therefore established between Applicant's claimed invention, as recited in Claim 15, and the teachings of Lin. Applicant teaches a permanent mask of passivation 32 while Lin teaches a temporary mask of photoresist 37.

In light of the above-described key difference between Applicant's claimed invention and the teachings of Lin, Applicant believes that Amended Claim 15 is not anticipated by Lin under 35 USC 102(e). Applicant respectfully requests that the rejection of Claim 15 under 35 USC 102(e) be removed in light of Amended Claim 15. In addition, Claims 16-19 and 22 represent patentably distinct, further limitations on Claim 15 and should likewise not be rejected under 35 USC 102(e) if the rejection of Claim 15 is removed.

Reconsideration of Claims 15-19 and 22 rejected under 35 U.S.C. 102(e) as being unpatentable over Lin (U.S. 6,426,556) is requested based on Amended Claim 15 and on the above remarks.

Reconsideration of Claims 1-14, 20, 21, 23, 26, 27, 32, 33, and 36 rejected under 35 U.S.C. 103(a) as being unpatentable over Lin (U.S. 6,426,556) in view of Chiang (US 2002/0086520),

AAPA, and Mistry et al (US 6,077,726) is requested based on Amended Claims 1, 8, and 15 and on the following remarks.

Applicant has amended Claims 1 and 8 have been amended to remove the phrase, "wherein said layer of passivation is not photoresist," that the Examiner has deemed new matter. For example, Amended Claim 1 now reads:

1. (Currently Amended) A method for forming a metal bump on a semiconductor substrate, comprising the steps of:

providing a semiconductor substrate, said semiconductor substrate having been provided in or on the surface thereof with a contact pad, said contact pad sitting on an underlying layer of dielectric and being in electrical contact with at least one point of electrical contact in or on the surface of said substrate;

depositing a layer of passivation over the surface of said layer of dielectric underlying the contact pad, including the surface of said contact pad ~~wherein said layer of passivation is not photoresist;~~

patterning and etching said layer of passivation, creating an opening in said layer of passivation having a first diameter, partially exposing the surface of said contact pad over a surface area of said first diameter,

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said first diameter of said opening created in said layer of passivation being smaller than a surface area of said contact pad by an amount;

20           etching said contact pad, using said layer of passivation as a mask, partially or completely first removing said contact pad from above the surface of said layer of dielectric, creating a opening in said contact pad having a diameter being about equal to said first diameter;

25           sputtering a layer of Under Bump Metallurgy (UBM) over the surface of said layer of passivation, including said opening created in said contact pad;

              depositing and patterning a layer of photoresist, creating an opening in the photoresist with a slightly  
30   larger dimension than said first diameter;

              electroplating a layer of bump metal in the photoresist opening; stripping the layer of photoresist and etching said layer of UBM, using said layer of bump metal as a mask; and reflowing the surface of said layer of bump  
35   metal, forming the metal bump.

Claim 8 has been similarly amended.

Applicant notes that Amended Claims 1 and 8 teach methods wherein a passivation layer 32 is patterned to form openings

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through said passivation layer 32 that expose particular region of the underlying contact pad 24 (lines 13-19). This contact pad is then etched down (partially or completely) using the passivation as a mask (lines 20-24). Next, and most importantly, the patterned passivation layer 32 is not removed, rather, subsequent layers of material - in this case UBM 33, are deposited overlying the passivation layer 32 (lines 25-27).

This last observation is most important because Applicant respectfully believes that Examiner's assignment (in comments on page 5 of the Office Action of July 15, 2003) of layer 37 of Lin (photoresist) as equivalent to layer 32 of Applicant's invention (passivation) is not correct. Lin clearly teaches depositing and defining a photoresist layer 37 to expose the contact pad 24 where etching is planned (Fig. 10). After etching, this photoresist layer 37 is removed (Fig. 11). Subsequent layers, such as the UBM 33, are not deposited over the photoresist layer 37 since this layer 37 is no longer present (Fig. 12.)

Amended Claims 1, 8, and 15 make clear that the passivation layer 32 used to mask the contact pad 24 etching is a permanent layer - subsequent process steps deposit layers, such as UBM 33, that overlie the passivation layer 32. Lin teaches a clearly different method wherein a temporary photoresist layer 37 is

used for defining the contact pad 24 etch. Even if one were to assign the photoresist layer 37 of Lin as equivalent to the passivation layer 32 of Applicant's claimed invention (by declaring that the photoresist layer 37 serves a passivating function at some step), the above-described difference in the recited steps in the claimed invention make clear that this equivalence cannot be sustained over the entirety of the claimed invention.

The key feature of the present invention, where the passivation layer 32 is defined as an etching mask for the previously formed contact pad 24, and where this passivation layer 32 is not removed, is not taught or suggested, separately or in combination, in the cited art of Lin, Chiang, AAPA, and/or Ministry. Applicant believes, therefore, that it would not have been obvious, therefore, for one skilled in the art at the time of the invention to have practiced the claimed invention. Therefore, Applicant respectfully requests that the rejection of Claims 1, 8, and 15, under 35 USC 103(a) be removed. Further, Claims 2-7, 9-14, 20, 21, 23, 26, 27, 32, 33, and 36 represent patentably distinct further limitations on Claims 1, 8, and 15, and should not be rejected under 35 USC 103(a) if Claims 1, 8, and 15 are not rejected.

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Reconsideration of Claims 1-14, 20, 21, 23, 26, 27, 32, 33, and 36 rejected under 35 U.S.C. 103(a) as being unpatentable over Lin (U.S. 6,426,556) in view of Chiang (US 2002/0086520), AAPA, and Mistry et al (US 6,077,726) is requested based on Amended Claims 1, 8, and 15 and on the above remarks.

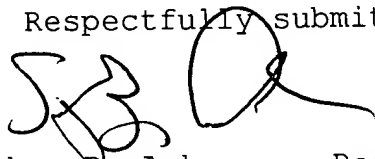
Reconsideration of Claims 24, 25, 39, and 40 rejected under 35 U.S.C. 103(a) as being unpatentable over Lin (U.S. 6,426,556) in view of Kung et al (US 6,197,613) is requested based on Canceled Claims 24, 25, 39, and 40.

Applicants have reviewed the prior art made of record and not relied upon and have discussed their impact on the present invention above.

Allowance of all Claims is requested.

It is requested that should the Examiner not find that the Claims are now Allowable that the Examiner call the undersigned at 989-894-4392 to overcome any problems preventing allowance.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'S. B. Ackerman', with a large, stylized flourish at the end.

Stephen B. Ackerman, Reg. No. 37,761